Attorney Docket
No. P0314

APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE: Condensate Drain Pan For Air Conditioning System

Condensate Drain Pan For Air Conditioning System

Description

Technical Field

This invention relates generally to air conditioning systems and in particular to a drain pan adapted to capture condensate from a cooling coil in an air conditioning system.

Background Art

Air conditioning systems typically include a blower for circulating air to and from an indoor space to be heated or cooled and apparatus for cooling or heating the circulated air, depending on the mode of operation of the system (i.e., either heating or cooling mode). A device (e.g., a compressor) is also provided for circulating a heat transfer fluid (e.g., a vapor compression refrigerant) between indoor and outdoor heat exchanger coils, whereby the air supplied to the space is cooled or heated. When the system is a conventional air conditioning system (i.e., not a heat pump system), the indoor coil functions as a cooling coil (i.e., as an evaporator when a vapor compression refrigerant is used as a heat transfer fluid) to transfer heat from the air flowing across the outside of the coil to the heat transfer fluid flowing inside the coil, and the outdoor coil functions as a heating coil (i.e., as a condenser when a vapor compression refrigerant is used as a heat transfer fluid) to transfer heat from the heat transfer fluid flowing inside the outdoor coil to outdoor air flowing across the outside of the coil. When the air conditioning system is configured as a heat pump, the indoor coil functions as a cooling coil and the outdoor coil functions as a heating coil in the cooling mode, as in a conventional air conditioning system. However, in the heating mode, the functions are reversed (i.e., the indoor coil functions as a heating coil and the outdoor coil functions as a cooling coil).

When a heat exchanger coil is operated as a cooling coil (e.g., an evaporator), air flowing across the coil is dehumidified as well as cooled, causing condensation to form on the coil. This condensation must be disposed of to prevent freezing of the coil and damage to the surrounding building structure. Typically, a drain pan is located beneath the coil to receive condensate runoff. The pan includes an opening in a bottom part of the pan to conduct the condensate accumulated in the pan to an external drainage conduit. Drain pans of various types are known in the art, as exemplified by the following United States patents: 4,474,232; 5,071,027; 5,511,386; 5,715,697; 5,966,959; and 6,360,911 B1.

It is advantageous to reduce water retention in the pan to the extent feasible, not only to reduce the likelihood of condensate spillage from the pan onto the adjacent building structure, but also to inhibit the formation of mold, rust and other undesirable byproducts of stagnant water in the pan. Further, air flowing through the heat exchanger coil may pick up moisture from excessive water accumulation in the pan, which may result in unwanted humidity in the air supplied to an indoor space.

Summary of the Invention

In accordance with the present invention, a drain pan for an air conditioning system is provided . The pan is comprised of an inner front wall, an inner back wall and opposed inner side walls defining an inner perimeter of the pan, and an outer front wall, an outer back wall and opposed outer side walls defining an outer perimeter of the pan. The outer front wall has at least one drain opening to allow condensate to drain from the pan and a trough intermediate the inner perimeter and the outer perimeter. The trough is adapted to receive condensate runoff from an air conditioning coil and to conduct the condensate to the drain opening.

In accordance with one aspect of the invention, a portion of the trough between the inner back wall and the outer back wall includes a central hump to facilitate drainage of condensate toward both of the outer side walls. In accordance with another aspect of the invention, the pan is sloped from back to front to conduct

condensate to the front part of the pan where the drain opening is located. In accordance with yet another aspect of the invention, a lowermost portion of the trough is defined by a non-flat surface to reduce condensate accumulation in the pan and to enhance condensate flow in the trough.

In accordance with one embodiment of the invention, the trough includes a front trough between the inner front wall and the outer front wall, a back trough between the inner back wall and the outer back wall, a first side trough between a first inner side wall and a first outer side wall and a second side trough between a second inner side wall and a second outer side wall. In accordance with another embodiment of the invention, the drain pan further includes first and second drain openings in the outer front wall. The first opening is generally aligned with the first side trough and said second drain opening is generally aligned with the second side trough.

In accordance with a preferred embodiment of the invention, the front trough is defined by a sloped surface extending downwardly and inwardly from the outer front wall and a curved surface extending downwardly and outwardly from the inner front wall. The intersection of these two surfaces defines a non-flat lowermost portion of the front trough. The back trough is defined by a first curved surface extending dowardly and outwardly from the inner back wall and a second curved surface extending downwardly and inwardly from the outer back wall. The first and second curved surfaces have different radii of curvature, such that their intersection also defines a non-flat lowermost portion of the back trough. Each side trough is defined by first and second sloped surfaces in downwardly converging relationship, with a curved surface intermediate the first and second sloped surfaces. The curved surface defines a lowermost portion of each side trough. Each side trough defines a channel for condensate flow. Each channel is at its deepest and narrowest proximate to the front trough and at its widest and shallowest proximate to the back trough.

Brief Description of Drawings

FIG. 1 is a front elevation view of an "A-Coil" heat exchanger, with a drain pan according to the present invention positioned to capture condensate runoff from the heat exchanger;

FIG. 2 is a perspective view of the drain pan of FIG. 1;

FIG. 3 is a partial perspective view of the drain pan of FIG. 1, showing the front part of the pan;

FIG. 4 is a partial perspective view of the drain pan of FIG. 1, showing the back part of the pan;

FIG. 5 is a top plan view of the drain pan of FIG. 1;

FIG. 6 is a sectional view, taken along the line 6-6 in FIG. 5;

FIG. 7 is a sectional view, taken along the line 7-7 in FIG. 5;

FIG. 8 is a sectional view, taken along the line 8-8 in FIG. 2;

FIG. 9 is a sectional view, taken along the line 9-9 in FIG. 2; and

FIG. 10 is a sectional view, taken along the line 10-10 in FIG. 2.

Best Mode for Carrying Out the Invention

The best mode for carrying out the invention will now be described with reference to the accompanying drawings. Like parts are marked in the specification and drawings with the same respective reference numbers. In some instances, proportions may have been exaggerated in order to more clearly depict certain features of the invention.

Referring to FIGS. 1-10, a condensate drain pan **10** according to the present invention is adapted to be positioned underneath a heat exchanger coil **12** in a typical air conditioning system to capture condensate runoff from coil **12** when coil **12** is operated as a cooling coil to cool air flowing through coil **12**. For example, coil **12** may be used as an "evaporator" coil, to cool air flowing through coil **12** by evaporating a vapor compression refrigerant flowing inside tubes **13** of coil **12**. Coil **12** is depicted in FIG. 1 as a conventional "A-Coil", comprised of a pair of slabs **12a,**

12b coupled together at their respective upper ends and extending downwardly in diverging relationship. Each slab **12a, 12b** is depicted as having two parallel rows of heat transfer fluid carrying tubes **13**. However, one skilled in the art will recognize that coil **12** can be configured with more or fewer than two rows of tubes **13**.

As can be best seen in FIGS. 2-5, drain pan **10** has a generally rectangular shape and is made of plastic, preferably by an injection molding process. Pan **10** has an outer front wall **14**, an outer back wall **16** and opposed outer side walls **18, 20**. Walls **14, 16, 18, 20** define a generally rectangular outer perimeter of pan **10**. Pan **10** further includes an inner front wall **22**, an inner back wall **24** and opposed inner side walls **26, 28**. Walls **22, 24, 26, 28** define a generally rectangular inner perimeter of pan **10**, which surrounds a central opening **29**. Opening **29** allows the air to be cooled to flow upwardly through pan **10** into coil **12** between slabs **12a, 12b** and then outwardly through slabs **12a, 12b**, where heat is transferred from the air to the heat transfer fluid in tubes **13** to cool the air. Located on inner front wall **22** and inner back wall **24** are mounting clips **30**, which are adapted for mounting heat exchanger coil **12** in a fixed position with respect to drain pan **10** in a conventional manner. As can be best seen in FIG. 2, respective intermediate portions **26a, 28a** of inner side walls **26, 28** are reduced in height compared to front and back walls **22, 24** to enhance the air flow through coil **12**. Inner side wall **26** further includes sloped portions **26b,26c** on opposed sides of intermediate portion **26a**. Sloped portion **26b** is proximate to inner front wall **22** and sloped portion **26c** is proximate to inner back wall **24**. Inner side wall **28** further includes sloped portions **28b, 28c** on opposed sides of intermediate portion **28a**. Sloped portion **28b** is proximate to inner front wall **22** and sloped portion **28c** is proximate to inner back wall **24**.

The bottom part of drain pan **10** between the inner perimeter and outer perimeter thereof is a condensate collection region comprised of a front trough **32**, a back trough **34** and opposed side troughs **36, 38**. Front trough **32** is located between outer front wall **14** and inner front wall **22**. Back trough **34** is located between outer back wall **16** and inner back wall **24**. Side trough **36** is located

between outer side wall **18** and inner side wall **26** and side trough **38** is located between outer side wall **20** and inner side wall **28**.

Outer front wall **14** includes respective primary and secondary drain openings **40, 42** adjacent side trough **36** and respective primary and secondary drain openings **44, 46** adjacent side trough **38**. Both sets of drain openings are adapted for attachment to an external conduit (not shown) for draining condensate from pan **10**. By having two sets of drain openings, either side of pan **10** may be used to drain condensate therefrom. The set of drain openings not in use is capped to prevent condensate drainage therefrom. As can be best seen in FIGS. 2, 3, 5 and 10, primary drain opening **40** is generally aligned with side trough **36** and is located proximate to a relatively small depression **47**, which is located at the confluence of side trough **36** and front trough **32**, to facilitate drainage of condensate from pan **10**. Similarly, primary drain opening **44** is located proximate to a relatively small depression **48**, which is located at the confluence of side trough **38** and front trough **32**. Depressions **47, 48** define the lowermost portions of pan **10**. In the event that the primary drainage conduit in use becomes blocked, condensate will back up into front trough **32** through the corresponding primary drain opening **40** or **44** until it reaches the level of the corresponding secondary drain opening **42** or **46**, whereupon condensate will flow out of drain pan **10** through the corresponding secondary drain **42** or **46**.

The respective bottom portions of side troughs **36, 38** are sloped from back trough **34** to front trough **32** at an angle of about 2° relative to a horizontal axis, to enhance the flow of condensate to the front part of pan **10**, as shown by arrows **50** in FIG's 5 and 6. Further, as can be best seen in FIG. 7, back trough **34** has a central raised portion or hump **51** and is sloped from hump **51** toward both side troughs **36, 38** at an angle of about 4° relative to a horizontal axis, to cause condensate in back trough **34** to flow away from hump **51** in the direction of both side troughs **36, 38** (as represented by arrows **52, 54**, respectively). Therefore, pan **10** is configured to direct the flow of condensate from back trough **34** into side troughs **36, 38** and from side troughs **36, 38** into front trough **32**.

As can be best seen in FIG. 6, front trough **32** is defined by a sloped surface **56** extending downwardly and inwardly from outer front wall **14** at a substantially constant angle of about 20° relative to a horizontal axis and a curved surface **58** extending downwardly and outwardly from inner front wall **22** at a predetermined radius of curvature (e.g., about 1.1343 inches). The intersection of surfaces **56, 58** defines a non-flat bottom **32a** of front trough **32**, which enhances condensate flow in front trough **32** and reduces condensate accumulation therein. Bottom **32a** is slightly elevated with respect to depressions **47, 48**, so that substantially all of the condensate in pan **10** finds its way into one of the depressions **47, 48**. Condensate will flow from the depression **47, 48** that is in communication with the primary drain **40, 44** in use. However, condensate in the opposite depression **47, 48** will remain in pan **10**, but the amount that remains is negligible because volume of depressions **47, 48** is relatively small. Further, by configuring bottom **32a** so that it is relatively narrow channel defined by a non-flat surface, the flow of condensate in front trough **32** is enhanced, which facilitates drainage of the condensate from pan **10**.

As can be best seen in FIG's 6 and 9, back trough **34** is defined by curved surfaces **60, 62** having different radii of curvature. For example, surface **60** preferably has a radius of curvature of about 0.4095 inch, while surface **62** preferably has a radius of curvature of about 0.4960 inch, so that the curvature of surface **60** is slightly more pronounced than the curvature of surface **62**. Curved surface **60** extends downwardly and outwardly from inner back wall **24** and curved surface **62** extends downwardly and inwardly from outer back wall **16**. The intersection of surfaces **60, 62** defines a non-flat bottom **34a** of back trough **34**, which along with hump **51** enhances condensate flow in back trough **34** and reduces condensate accumulation therein.

As can be best seen in FIGS. 8 and 10, side trough **36** is defined by sloped surfaces **64, 66** extending downwardly and inwardly from outer side wall **18** and a sloped surface **68** extending downwardly and outwardly from inner side wall **26**. A curved surface **70** is intermediate sloped surfaces **66, 68** and defines a non-flat

bottom portion of side trough **36**. Sloped surfaces **66, 68** are sloped at angles of about 20°and 70° degrees, respectively, relative to a horizontal axis, along the entire length of side trough **36**. However, the slope angle of surface **64** changes along the length of side trough **36**. For example, the slope angle of surface **64** is greatest proximate to front trough **32** (e.g., about 20°), as shown in FIG. 10 and least proximate to rear trough **34** (e.g., about 12°). The slope angle of surface **64** is about 16°at the approximate midpoint of side trough **36** between front and back troughs **32, 34**, as shown in FIG. 8.

The radius of curvature of curved surface **70** also varies along the length of side trough **36**. The curvature is more pronounced in proximate to front trough **32** (e.g., radius of curvature of about 0.3344 inch), as shown in FIG. 9 and least pronounced proximate to back trough **34** (e.g., radius of curvature of about 0.4752 inch). At the approximate midpoint of side trough **36**, the radius of curvature of surface **70** is intermediate the respective radii of curvature of surface **70** proximate to front and back troughs **32, 34** (e.g., about 0.4048 inch). As previously described, bottom portion **36a** slopes downwardly from back trough **34** to front trough **32** at an angle of about 2°, so that side trough **36** is at its deepest proximate to front trough **32** and is at its shallowest proximate to back trough **34**. Although described in detail herein, one skilled in the art will recognize that side trough **38** has the same configuration as side trough **36**, as described hereinabove.

In accordance with the present invention, a drain pan is provided for use in an air conditioning system. The pan is adapted to enhance the flow of condensate captured by the pan toward the drain opening, to facilitate drainage of condensate from the pan and inhibit accumulation of condensate in the pan.

The best mode for carrying out the invention has now been described in detail. Since changes in and additions to the above-described best mode can be made without departing from the nature, spirit and scope of the invention, the invention is not to be limited to the above-described best mode, but only by the appended claims and their equivalents.